FORM PTO-1390
(REV 5-93)

U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
3036/49866

US APPLICATION NO (if known, see 37 CFR 1 5)
09/830408

INTERNATIONAL APPLICATION NO. PCT/GB99/03496	INTERNATIONAL FILING DATE 27 October 1999 (27.10.99)	PRIORITY DATE CLAIMED 27 October 1998 (27.10.98)

TITLE OF INVENTION: **METHOD OF AND APPARATUS FOR POWER CONTROL**

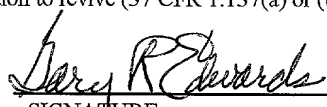APPLICANT(S) FOR DO/EO/US: **Anthony Peter HULBERT**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S C. 371(c)(2)).

   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).

   b. [X] has been transmitted by the International Bureau **(Form PCT/IB/308 attached)**

   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)

6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))

   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).

   b. [ ] have been transmitted by the International Bureau.

   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.

   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **(UNEXECUTED - 2 pages)**

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern other document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.

    [ ] A SECOND or SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information: **2 sheets of drawings (Figures 1 and 2); International Preliminary Examination Report; 1st page of published International Application**

U.S. APPLICATION NO. (if known, see 37 CFR 1.5	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/830408	PCT/GB99/03496	3036/49866

17. [ ] The following fees are submitted:

	CALCULATIONS	PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EPO or JPO $860.00	$860.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) $690.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482)		
but international search fee paid to USPTO (37 CFR 1.445(a)(2) $710.00		
Neither international preliminary examination fee (37 CFR 1.482) nor		
international search fee (37CFR 1.445(a)(2) paid to USPTO . . . . $ 1000.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482)		
and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		

ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$130.00	

Claims	Number Filed	Number Extra	Rate		
Total Claims	11- 20 =		X $18.00	$	
Independent Claims	2- 3 =		X $80.00	$	
Multiple dependent claims(s) (if applicable)			+ $270.00	$	
		TOTAL OF ABOVE CALCULATIONS =		$130.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
			SUBTOTAL =	$990.00	
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
			TOTAL NATIONAL FEE =	$990.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). $40.00 per property +				$	
			TOTAL FEE ENCLOSED =	$990.00	

	Amount to be:	$
	refunded	
	charged	$

a. [X] A check in the amount of $ **990.00** for the filing fee is enclosed
b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.
c. [X] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. __05-1323__. **(Attorney Docket No. 3036/49866.)** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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REGISTRATION NUMBER
27 April 2001
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: ANTHONY P. HULBERT

Serial No.:   NOT YET ASSIGNED

Filed: APRIL 27, 2001

Title: METHOD OF AND APPARATUS FOR POWER CONTROL

PRELIMINARY AMENDMENT

Box Non-Fee Amendment   April 27, 2001
Commissioner for Patents
Washington, D.C.   20231

Sir:

Please enter the following amendments to the claims prior to the examination of the application.

IN THE CLAIMS:

Please amend the claims as follows: **(A copy of a marked up version with markings to show changes made is attached.)**

5.   (Amended) A method according to Claim 1, wherein the time interval is a time slot.

6.   (Amended) A method accord to Claim 1, wherein the communications system is a spread spectrum communications system.

REMARKS

Entry of the amendments to the claims before examination of the application is respectfully requested. These claims have been amended to remove multiple dependencies.

If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

It is respectfully requested that, if necessary to effect a timely response, this paper be considered as a Petition for an Extension of Time sufficient to effect a timely response and shortages in other fees, be charged, or any overpayment in fees be credited, to the Account of Evenson, McKeown, Edwards & Lenahan, P.L.L.C., Deposit Account No. 05-1323 (Docket #3036/49866).

Respectfully submitted,

Gary R Edwards

Gary R. Edwards
Registration No. 31,824

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

5.   (Amended) A method according to [any of Claims 1 to 4,] <u>Claim 1,</u> wherein the time interval is a time slot.

6.   (Amended) A method accord to [any one of Claims 1 to 5,] <u>Claim 1,</u> wherein the communications system is a spread spectrum communications system.

METHOD OF AND APPARATUS FOR POWER CONTROL

The present invention relates to a method of and apparatus for power control, of the type used in a communication system, for example, in a spread-spectrum communication system, such as a Code Division Multiple Access (CDMA) communication system.

In a CDMA cellular communication system, power control is used to equalize signal to noise (S/N) ratios of the signals received at a base station from various mobile terminals. In the term 'signal to noise ratio', the term 'noise' is intended to include interference in the form of signals from other mobile terminals, as well as background noise.

A known technique involves measuring the S/N ratio in respect of signals received from a given mobile terminal over a measurement interval and comparing the measured S/N ratio against a desired threshold. If the measured S/N ratio exceeds the desired threshold, a binary 1 (or 0, depending upon the convention employed) is transmitted (within the plurality of signals transmitted from the base station) to the mobile terminal originating the given signal. If the measured S/N ratio is lower than the desired threshold, a binary 0 (or 1, depending upon the convention employed) is transmitted to the given mobile terminal. The mobile terminal, in turn, responds by reducing its transmission power by, for example, 1 dB if a 1 (or 0) is received or by increasing its power by 1 dB if a 0 (or 1) is received. In this way, the received S/N ratio is held approximately constant as path loss between the given mobile station and the base station varies and/or as the level of interference at the base station from other mobile terminals varies.

The above technique is effective in the transmission of continuous data where any transients associated with the initial setting of transmitter power at

the mobile terminal can be ignored. However, where individual bursts (frames) of data are transmitted, for example packet data, the mobile terminal must set its initial transmitter power according to a so-called open loop power control technique. In this technique, the base station signals to the mobile terminal(s) the power at which the base station is transmitting; this can be either the total power received or the power of a particular signal which the mobile(s) station is receiving, and the interference level at the base station. The mobile terminal measures the power level of the corresponding signal received from the base station and uses the signalled information, i.e. the information relating to signal strength at the base station, to determine the power at which the mobile terminal must transmit in order to produce a required S/N ratio at the base station. On average, this should be the correct power. However, in many CDMA systems the frequency used for transmission from the base station to the mobile terminal (down-link) is different from the frequency used for transmission from the mobile terminal to the base station (up-link). Such a scheme is known as a Frequency Division Duplex (FDD) technique. In an FDD technique, propagation of signals is non-reciprocal in the short term, for example, multi-path fading on the down-link is uncorrelated with multi-path fading on the up-link. This effect can be mitigated somewhat by averaging the power measurements at the mobile terminal over the likely fading period. However, this does not cater for the instantaneous path level fluctuations in the up-link direction, resulting in the power transmitted by the mobile terminal being too high or too low at the start of the frame.

In a typical CDMA system, Forward Error Correction (FEC) with interleaving is employed in order to mitigate the effects of fading and interference from other signals operating on the same frequency. If a known soft decision decoding technique is employed, the effect of the interleaving is to

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make the probability of uncorrectable errors in an interleaved frame a function
more of the average S/N ratio over the frame rather than, for example, the worst
case S/N ratio. Consequently, if the S/N ratio at the start of a frame is too high,
implementation of power control reduces the S/N ratio to the required threshold
by the end of the frame, but the overall average will be higher than necessary.
Conversely, if the S/N ratio at the start of a frame is too low, implementation of
power control increases the S/N ratio to the required threshold by the end of the
frame, but the overall average will be lower than necessary.

It is therefore an object of the present invention to obviate or at least
mitigate the above described disadvantages.

According to the present invention, there is provided a method of power
control in a communications system capable of transmitting a frame having a
plurality of time intervals from a transmitter to a receiver, wherein power
control is effected on the individual time intervals based upon information
passed from the receiver to the transmitter, wherein the receiver seeks to
maintain an average signal to noise ratio across the frame.

In accordance with a further aspect of the invention, there is provided a method
according to claim 1, wherein the method comprises: i.   for a first time
interval of a frame, setting the initial transmission power level; and   ii.   for
each subsequent time interval of the frame: measuring the received signal to
noise ratio over subsequent time intervals; determining the cumulative SNR
value over the received time interval of the frame; determining the number of
time intervals remaining in the frame; and, adjusting the transmission power
level in response to signalling from the receiver in respect of a further
subsequent time interval based upon said cumulative SNR value and the number
of time intervals remaining in the frame such that the required average signal to
noise ratio is substantially achieved.

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Thus, if the signal is received at a S/N ratio higher than necessary at the beginning of a frame, the method will ensure that the signal will be received at a level lower than the nominal S/N ratio by the end of the frame. Where multi-path fading occurs the use of this method will result in smaller variation in average power over the frame, leading to an improvement in system capacity.

In accordance with another aspect of the invention, there is provided a transmitter for a communication system operable to transmit in time frames having a plurality of time intervals, the transmitter comprising a power controller operable to: i.   for a first time interval of a frame, set the initial transmission power level; and,   ii.   for each subsequent time interval of the frame: measure the received signal to noise ratio over subsequent time intervals; determine the cumulative SNR value over the received time interval of the frame; determine the number of time intervals remaining in the frame; and, adjust the transmission power level in response to signalling from the receiver in respect of a further subsequent time interval based upon said cumulative SNR value and the number of time intervals remaining in the frame such that the required average signal to noise ratio is substantially achieved.

This differs from known techniques which try to modify the power level within each time interval so as to substantially keep to the predetermined signal to noise ratio during each interval.

Preferably, the time interval is a time slot.

At least one embodiment of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic diagram of the entities used in a communications system,

FIGURE 2 is a schematic diagram of a frame used by the system of Figure 1, and

FIGURE 3 is a flowchart of a method constituting an embodiment of the present invention.

Referring to Figure 1, a CDMA system comprises at least one base station 102 supporting a cell 104, the base station 102 being arranged to communicate with a mobile terminal 106 over a radio-frequency (RF) interface 108 by transmitting a frame 200 of data (Figure 2). The frame 200 comprises N time slots ts_0, ..., ts_{N-1}.

In operation, the frame 200 is transmitted from the mobile terminal 106 to the base station 102, during which power control is achieved by N adjustments of power corresponding to N time slots in the frame 200.

Referring to Figure 3, a required average S/N ratio γ_d at the base station 102 over the duration of the frame 200 is initially determined and set (step 300). A power level is then set so that the average S/N ratio γ_d per time slot at the base station 102 will be substantially met (step 300).

A subsequent time slot, ts_j, for which the power level is to be adjusted, is then selected (step 302) and the number of any remaining time slots, $N-j$, is determined (step 304). If the number of time slots remaining, $N-j$, is zero, no

further power levels are set for the frame 200 (step 306). If, however, one or more time slots remain, the sum of respective measured power levels received at the base station 102 during previous time slots is calculated (step 308). The calculation can be generally expressed as: $\sum_{i=0}^{j-1}\gamma_i$, where γ_i is the S/N ratio received in the ith slot.

Using the sum of the measured power levels, the predetermined average S/N ratio γ_d and knowledge of the number of remaining time slots, a predicted S/N ratio, γ_p is then calculated (step 310) and the value of γ_p is used to calculate the power level at which the mobile terminal 106 transmits signals to the base station 102. The equation used to calculate the predicted S/N ratio γ_p is derived as follows.

The predicted S/N ratio γ_p is calculated based upon the assumption that a target, of the average S/N ratio, γ_d, across the frame 200, will be met if the calculated predicted S/N ratio γ_p is maintained throughout the remainder of the frame 200, thereby keeping the average S/N ratio γ_d substantially constant over the frame 200.

Since $N\text{-}j$ power control intervals (time slots) remain in the frame 200 for which a power level is to be predicted, in order to satisfy the S/N ratio requirement of $N\gamma_d$ for the entire frame 200, the predicted S/N ratio γ_p for the remaining intervals, γ_p needs to satisfy the following equation:

$$\sum_{i=0}^{j-1}\gamma_i + (N-j)\gamma_p = N\gamma_d$$

Thus, the above equation is solved for γ_p and hence the predicted required power level (and therefore the next threshold) is calculated using the following equation:

$$\gamma_p = \frac{N\gamma_d - \sum_{i=0}^{j-1} \gamma_i}{N - j}$$

During the selected time slot, ts$_j$, the mobile terminal 106 transmits at the power level set (step 312) corresponding to the associated predicted S/N ratio γ_p.

A subsequent time slot is then selected (step 302) and the above-described procedure for calculating and setting power levels is repeated (steps 304 to 312).

Minor obvious modifications can be made within the normal ability of a skilled person to take account of non zero periods for measurement and for signalling within the power control sub-system.

Claims:

1.   A method of power control in a communications system capable of transmitting a frame having a plurality of time intervals from a transmitter to a receiver, wherein power control is effected on the individual time intervals based upon information passed from the receiver to the transmitter, wherein the receiver seeks to maintain an average signal to noise ratio across the frame.

2.   A method according to claim 1, wherein the method comprises:

i.   for a first time interval of a frame, setting the initial transmission power level; and

ii.   for each subsequent time interval of the frame:

measuring the received signal to noise ratio over subsequent time intervals;

determining the cumulative SNR value over the received time interval of the frame;

determining the number of time intervals remaining in the frame; and,

adjusting the transmission power level in response to signalling from the receiver in respect of a further subsequent time interval based upon said cumulative SNR value and the number of time intervals remaining in the frame such that the required average signal to noise ratio is substantially achieved.

3.   A method according to Claim 2, wherein the transmission power level for each subsequent slot is set by:

calculating a predicted signal to noise ratio γ_p using the sum of the measured power levels, the predetermined average S/N ratio γ_d, and the number of remaining time slots.

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4. A method according to Claim 2, wherein the required signal to noise ration γ_p is calculated based upon the assumption that a target, of the average signal to noise ratio, γ_d, across the frame, will be met if the calculated predicted signal to noise ratio γ_p is maintained throughout the remainder of the frame, thereby keeping the average signal to noise ratio γ_d substantially constant over the frame.

5. A method according to any one of Claims 1 to 4, wherein the time interval is a time slot.

6. A method according to any one of Claims 1 to 5, wherein the communications system is a spread spectrum communications system.

7. A method according to Claim 6, wherein the spread spectrum communications systems is a CDMA communications system.

8. A method according to Claim 4, wherein the power level setting step achieves a signal to noise ratio, γ_p, which is given by the formula:

$$\gamma_p = \frac{N\gamma_d - \sum_{i=0}^{j-1}\gamma_i}{N - j}$$

wherein γ_i is the S/N ratio received at the base station in the ith interval; $\sum_{i=0}^{j-1}\gamma_i$ is the sum of S/N ratios received corresponding to previous time intervals; and $N\gamma_d$ is the desired total S/N ratio sum over the frame.

AMENDED SHEET

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9.   A method according to Claim 6, wherein the duration of a frame corresponds to a burst comprising a plurality of consecutive CDMA frames.

10.   A method according to Claim 6, wherein the duration of a frame corresponds to the duration of a CDMA frame.

11.   A transmitter for a communication system operable to transmit in time frames having a plurality of time intervals, the transmitter comprising a power controller operable to:

i.   for a first time interval of a frame, set the initial transmission power level; and,

ii.   for each subsequent time interval of the frame:

measure the received signal to noise ratio over subsequent time intervals;

determine the cumulative SNR value over the received time interval of the frame;

determine the number of time intervals remaining in the frame; and,

adjust the transmission power level in response to signalling from the receiver in respect of a further subsequent time interval based upon said cumulative SNR value and the number of time intervals remaining in the frame such that the required average signal to noise ratio is substantially achieved.

AMENDED SHEET

09/830408

ABSTRACT

METHOD OF AND APPARATUS FOR POWER CONTROL

When transmitting bursty data, for example packet data, a mobile terminal uses
information relating to signal strength at the base station to determine the power
at which the mobile terminal must transmit in order to produce a required signal
to noise ratio at the base station. In frequency division duplex techniques,
multi-path fading on the down-link is uncorrelated with multi-path fading on
the up-link. Power measurements can be averaged at the mobile terminal over a
likely fading period. However, this does not cater for instantaneous power level
fluctuations in the up-link direction, which can result in the power transmitted
by the mobile terminal being too high or too low at the start of a frame. The
invention maintains a predetermined signal to noise ratio. At a given time slot,
a power level is determined which, over remaining time slots, is based on the
sum of power levels corresponding to previous time slots and the number of
time slots remaining in the frame. Where multi-path fading occurs, smaller
variations in average power over the frame will occur leading to improved
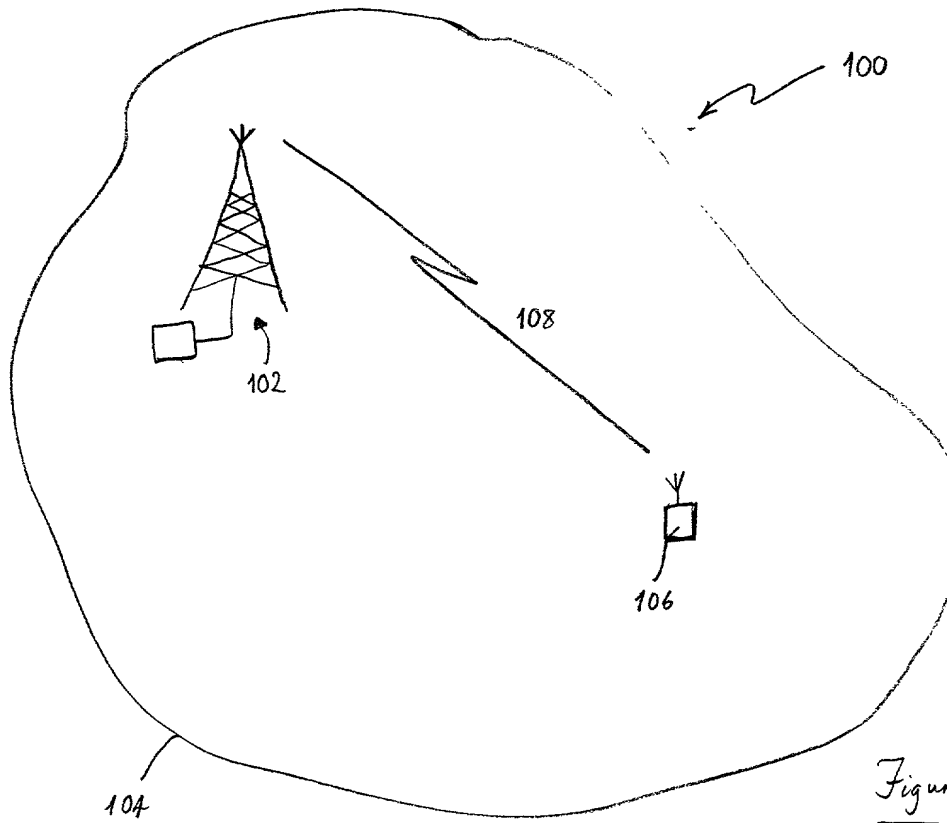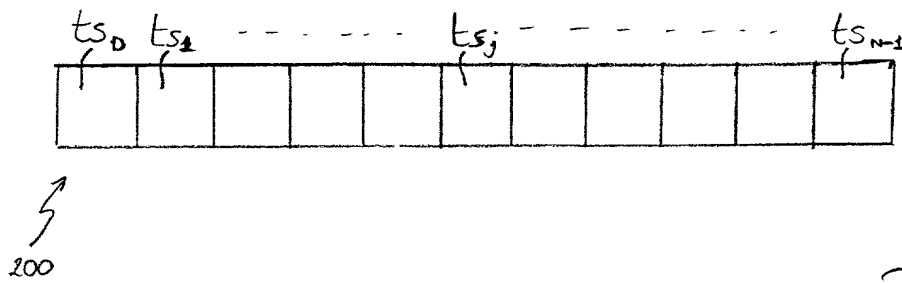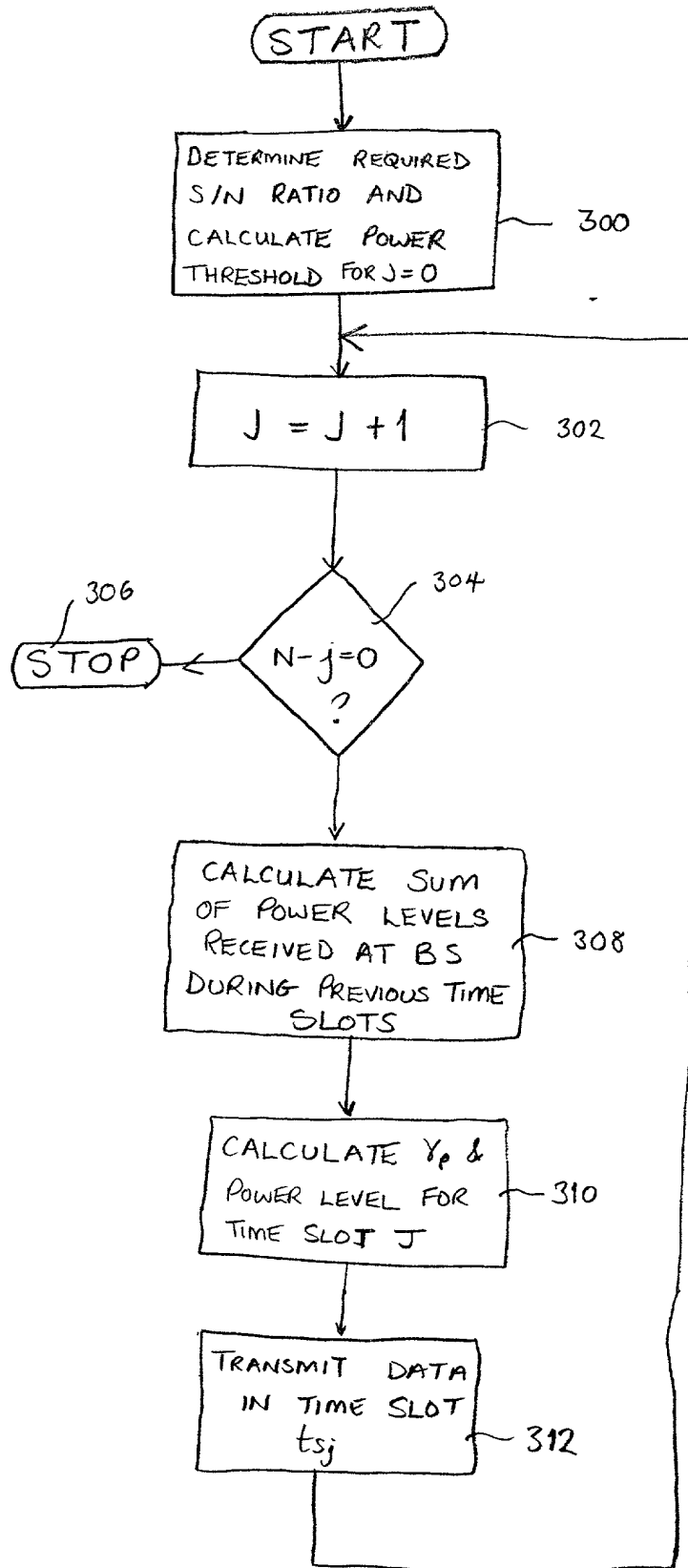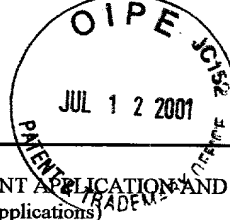system capacity.

[Figure 2]

Figure 1

Figure 2

Figure 3

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER 3036/49866

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD OF AN APPARATUS FOR POWER CONTROL

the specification of which (check only one item below):

[ ]   is attached hereto.

[ ]   was filed as United States application
        Serial No. _____
        on _____
        and was amended
        on _____ (if applicable).

[X]   was filed as PCT international application
        Number __PCT/GB99/03496_____
        on ____27 October 1999 (27.10.99)_____
        and was amended under PCT Article 19
        on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Great Britain	9823396.8	27 October 1998 (27.10.98)	[X] Yes [ ] No
			[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

U.S. DEPARTMENT OF COMMERCE Patent and Trademark Office

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national of PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120

U.S. APPLICATIONS			STATUS *(Check one)*		
U.S. APPLICATION NUMBER		U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.

PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS 48 Wilton Crescent, Shirley	CITY Southampton	STATE & ZIP CODE/COUNTRY SO15 7QH, GREAT BRITAIN
202	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Anthony Peter Hulbert		
DATE *11th May 2001*	Date	DATE

U.S. DEPARTMENT OF COMMERCE Patent and Trademark Office